22136009

International Baccalaureate®
Baccalauréat International
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BIOLOGY
HIGHER LEVEL
PAPER 3

Candidate session number

0	0								

Tuesday 14 May 2013 (morning)

1 hour 15 minutes

Examination code

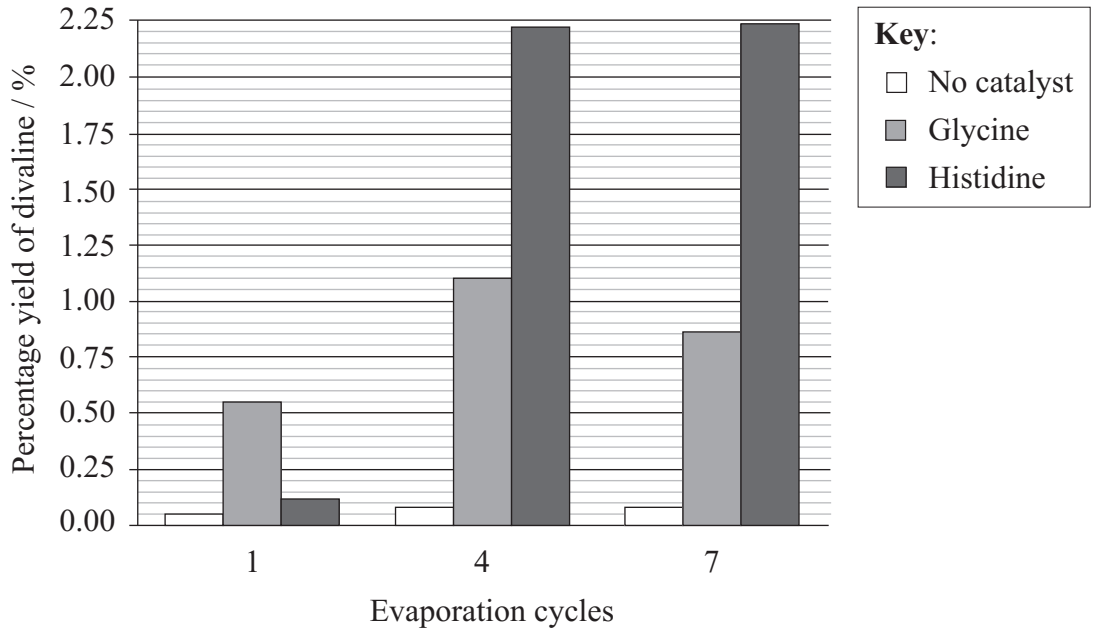
2	2	1	3	–	6	0	0	9

INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options.
- Write your answers in the boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is *[40 marks]*.

Option D — Evolution

D1. The synthesis of complex organic molecules in sea water is believed to be an important step in the evolution of life on Earth. Researchers investigated whether the evaporation of sea water containing amino acids could catalyse the formation of dipeptides such as divaline (valine-valine) under prebiotic Earth conditions. They placed different amino acid combinations in a chamber to simulate the evaporation cycles between high tides in shallow seas. In one investigation the amino acid valine was used as the substrate and the percentage yield of divaline was measured after different numbers of evaporation cycles. The experiment was repeated without a catalyst and with either glycine or histidine as catalysts.



[Source: D. Fitz et al. (2007) "Chemical evolution toward the origin of life", *Pure and Applied Chemistry*, 79 (12), pages 2101–2117. Reprinted with permission from IUPAC.]

(a) Compare the effectiveness of the two amino acid catalysts used in this experiment. *[3]*

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(Question D1 continued)

(b) This investigation was performed in a chamber at 85 °C leading to total evaporation of the salt water within one day. The atmosphere inside the chamber consisted of nitrogen, carbon dioxide and water vapour. Evaluate the experiment on the basis of similarity with conditions that existed on the prebiotic Earth. *[3]*

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(c) Outline other possible locations where conditions could have allowed the synthesis of organic molecules under prebiotic conditions. *[2]*

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D2. (a) State **two** assumptions that are made when the Hardy–Weinberg equation is used. *[2]*

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(b) Outline how isolation of a gene pool can lead to evolution. *[2]*

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(c) Distinguish between cultural and genetic evolution. *[2]*

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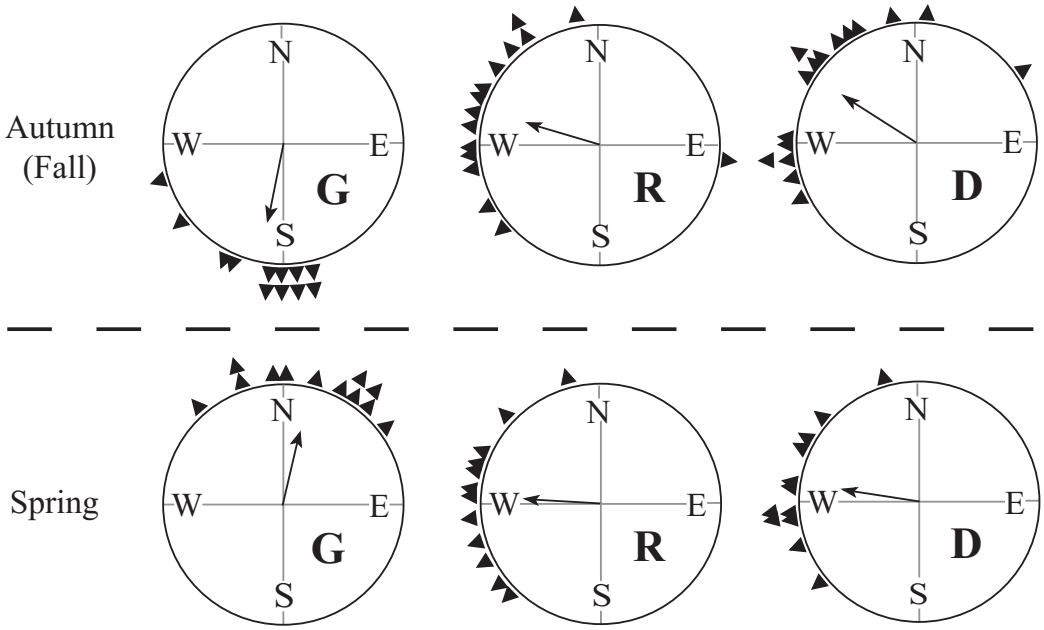
D3. Discuss the use of cladograms in phylogenetic studies. *[6]*

Option E — Neurobiology and behaviour

E1. European robins (*Erithacus rubecula*) migrate South in the autumn (fall) and North in the spring. They orient their direction of flight using the local magnetic field, which they detect through magnetoreceptors in the upper beak. The orientation of the birds in a captive environment was studied in spring and autumn, which are the times of year when the birds normally migrate. The response of the birds to green light, red light and total darkness was investigated. Triangles on the edge of circles indicate the mean direction flown by individual birds while the arrows indicate the overall mean direction of flight.



Key: **G** = green light **R** = red light **D** = total darkness

[Source: R. Wiltschko et al. (2008), "Light-dependent magnetoreception: orientation behaviour of migratory birds under dim red light",*The Journal of Experimental Biology*, 211 (20), 3344–3350: Figure 4. Reprinted with permission, jeb.biologists.org. http://jeb.biologists.org/content/211/20/3344.long]

(a) Identify the season and light conditions which result in the strongest northerly direction flown by the robins. *[1]*

Season: .....

Light conditions: .....

(This question continues on the following page)

(Question E1 continued)

(b) Distinguish between the effect of red light and green light on the behaviour of the robins in spring and autumn (fall). *[2]*

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(c) Based on the results of these experiments, suggest **one** possible conclusion that could be drawn regarding the effect of red light on the behaviour of robins. *[1]*

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(d) Using the data in the diagram, deduce with a reason, whether European robins migrate during the daytime or at night. *[2]*

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(e) Scientists anesthetized the beaks of some robins in order to deactivate the magnetoreceptors. Predict how this would affect their orientation in red light. *[1]*

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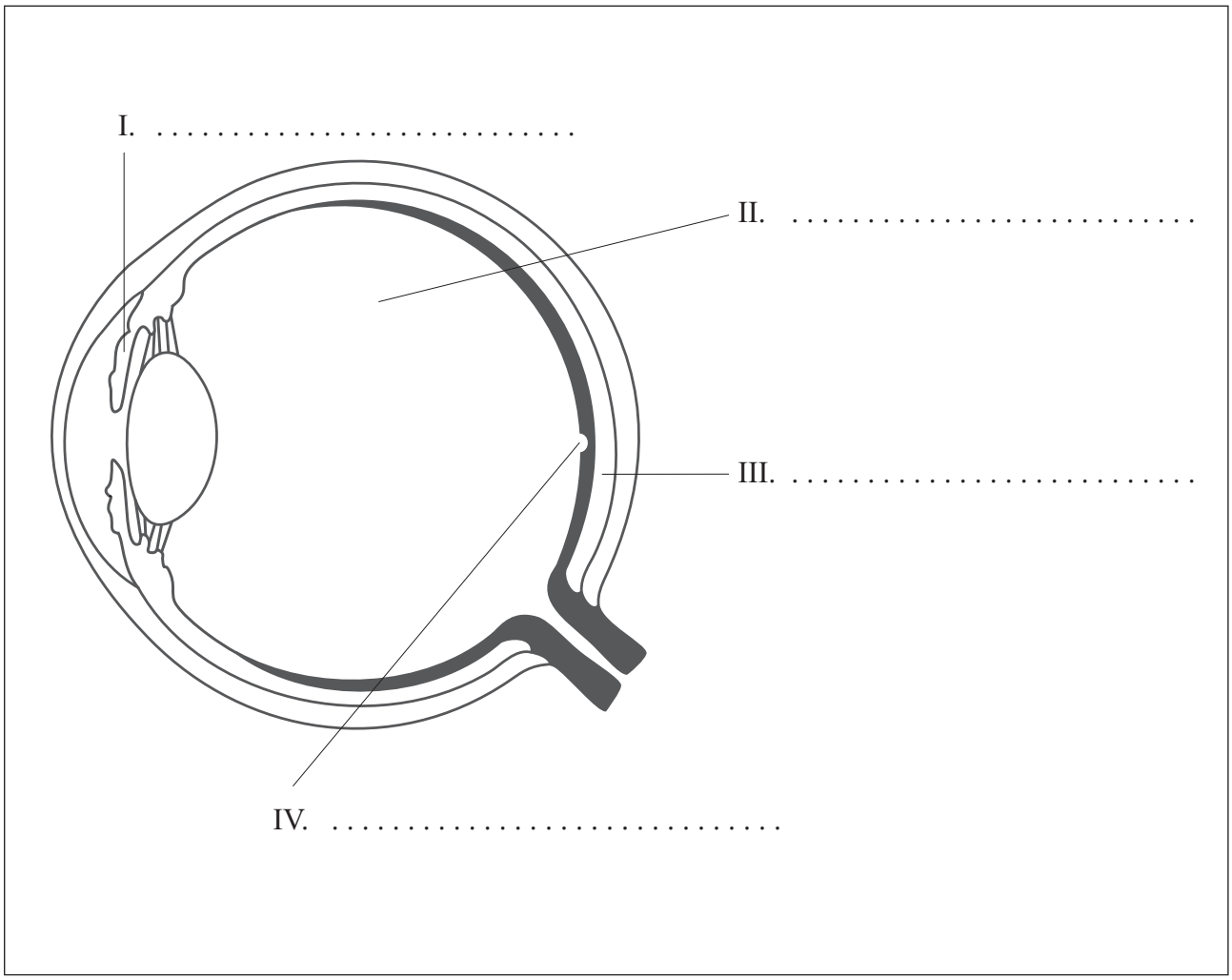
E2. (a) Label the following diagram of the eye. *[2]*



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(Question E2 continued)

(b) Outline how the pupil reflex can be used to indicate brain death. *[2]*

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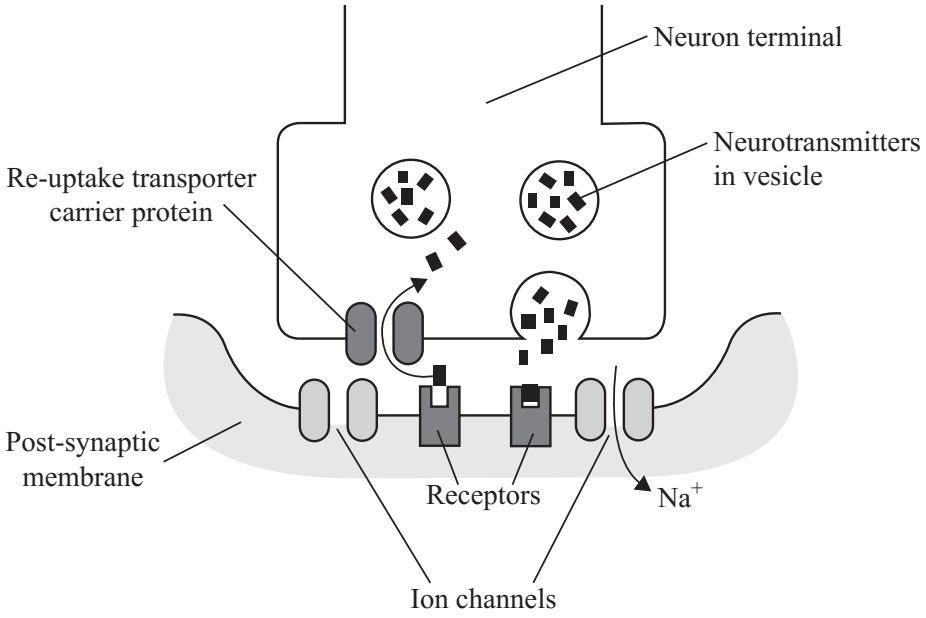
The diagram below shows a synapse where the neurotransmitter is dopamine and some of the processes that take place during nerve transmission.



[Source: Diagram reprinted with permission from the Faculty of Health, Birmingham City University, UK]

(c) Explain the effect of cocaine on neurotransmission at a synapse. *[3]*

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E3. Discuss the evolution of altruistic behaviour in animals other than humans. *[6]*

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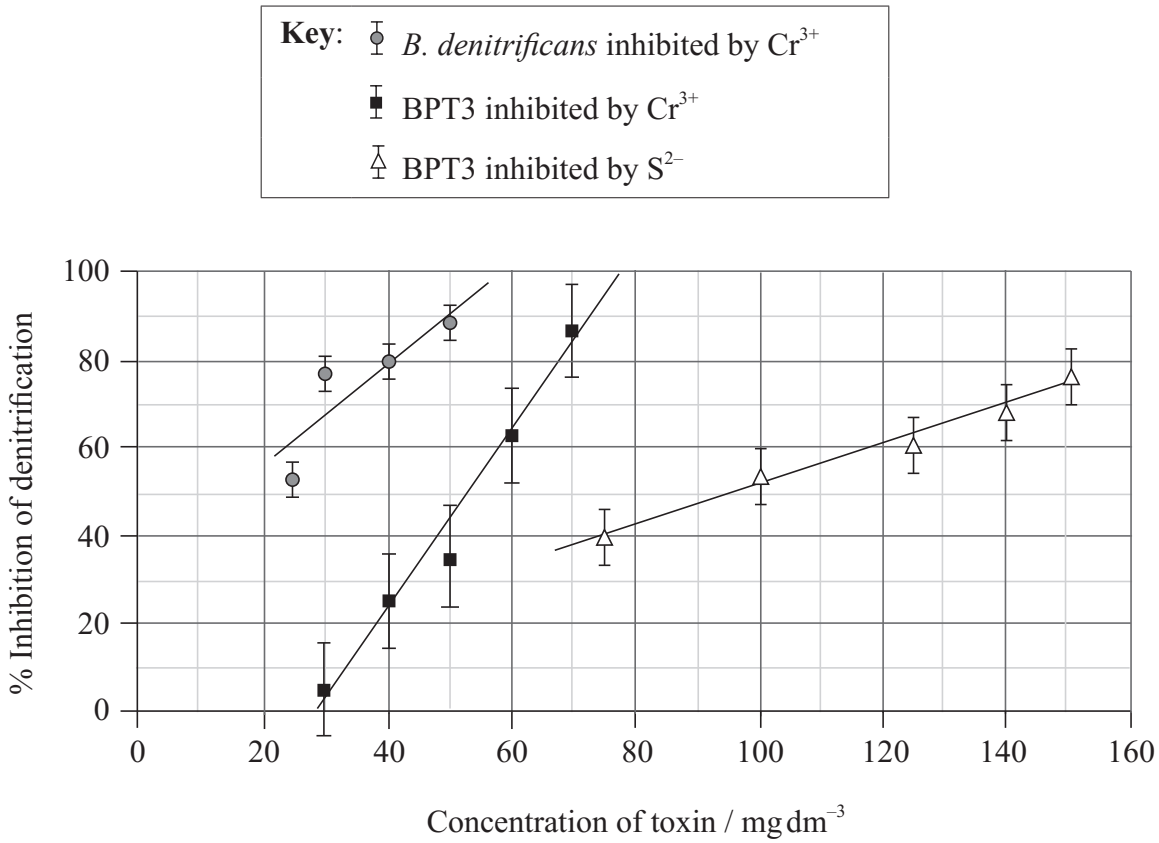
will not be marked.

Option F — Microbes and biotechnology

F1. Waste water from industrial processes contains a range of toxic substances that are harmful to the environment. These toxins include sulphide (S^{2-}) and metal ions such as chromium (Cr^{3+}). Microorganisms such as *Brachymonas denitrificans* that carry out denitrification of waste water, may be inhibited by these toxins. The effects of different concentrations of toxins on the rates of denitrification by *B. denitrificans* and a group of denitrifying bacteria named BPT3 are shown in the graph below.



[Source: With kind permission from Springer Science+Business Media: *World Journal of Biotechnology and Microbiology*, Identification of Efficient Denitrifying Bacteria from Tannery Wastewaters in Ethiopia and a Study of the Effects of Chromium III and Sulphide on Their Denitrification Rate, 20, 2004, 405–11, S. Leta]

(a) Predict the Cr^{3+} concentration that would cause 50 % inhibition in BPT3. *[1]*

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(This question continues on the following page)

(Question F1 continued)

(b) Waste water from some industrial processes contains high levels of Cr^{3+}. State, with a reason, which of the bacteria investigated should be used to treat this water. *[1]*

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(c) Compare the effect of Cr^{3+} and S^{2-} on the inhibition of BPT3. *[2]*

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(d) Raw sewage contains high level of nitrates. Explain the importance of denitrification of raw sewage by bacteria such as *B. denitrificans* and BPT3 before it is released into rivers. *[3]*

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F2. (a) One of the distinguishing features of the Archaea is that they are capable of inhabiting extreme environments such as extreme temperatures or anoxic conditions. Outline other extreme environments inhabited by the Archaea. *[2]*

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(b) Describe how methane can be made from biomass. *[3]*

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(c) Microscopic eukaryotes include *Euglena* and *Paramecium*. Outline the range of cellular structures used for locomotion in these organisms. *[2]*

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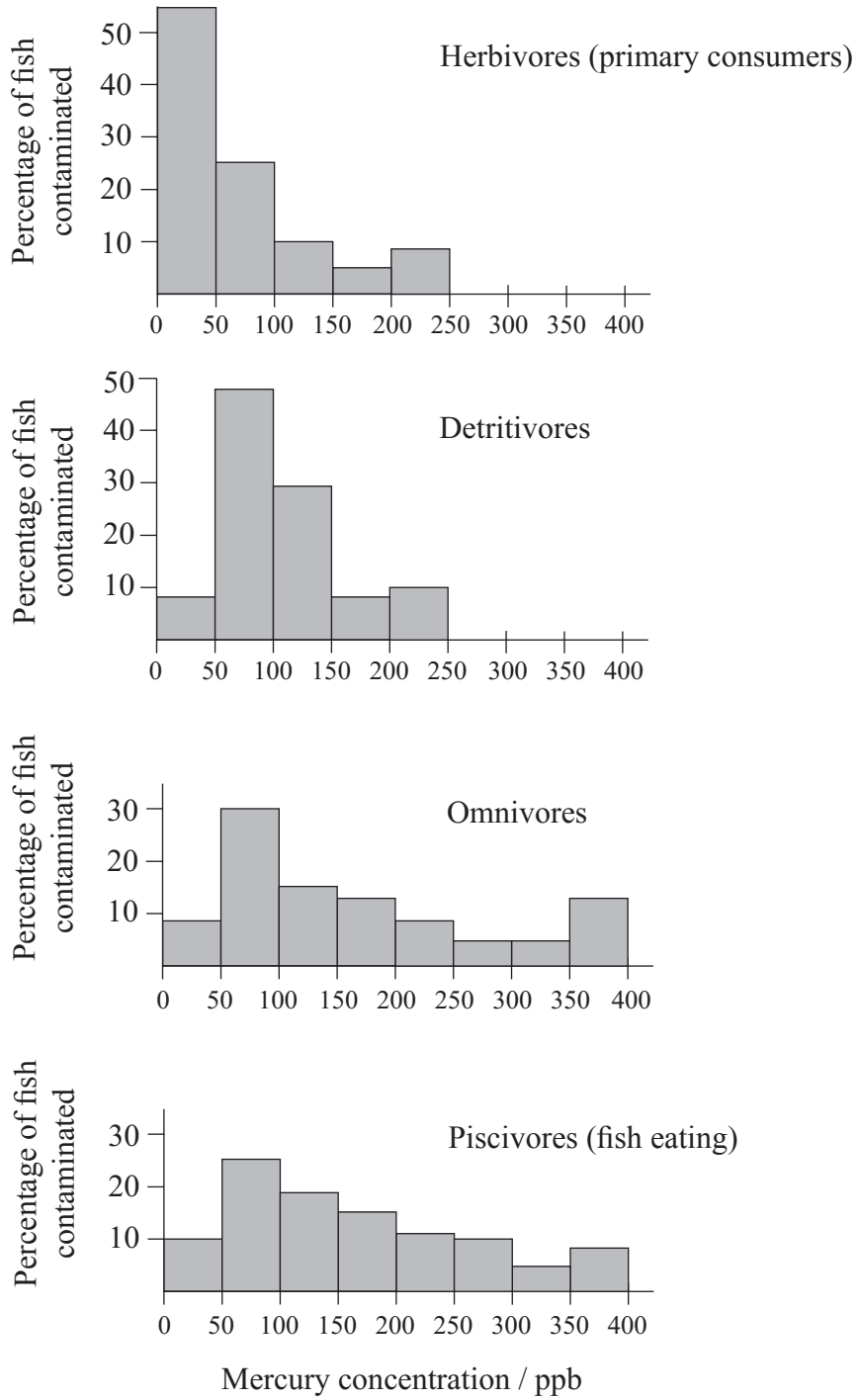
F3. Explain how bacteria are used in bioremediation of soil. *[6]*

Option G — Ecology and conservation

G1. Indigenous human populations living along riverbanks in the Amazon basin often rely heavily on fish as a major part of their diet. The data shown below come from a study that was carried out to investigate levels of mercury contamination in the Rio Negro basin in Brazil. Mercury concentration was measured in fish belonging to four different trophic levels and is shown in parts per billion (ppb).



[Source: With kind permission from Springer Science+Business Media: *Archives of Environmental Contamination and Toxicology*, Mercury Biomagnification in a Tropical Black Water, Rio Negro, Brazil, 45, 2003, 235–246, A. C. Barbosa et al.]

(This question continues on the following page)

(Question G1 continued)

(a) State the trophic level of the fish that presents the least risk of mercury contamination for human consumers. *[1]*

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(b) Compare the levels of mercury found in herbivores (primary consumers) and detritivores. *[2]*

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(c) Explain the large range of mercury concentrations seen in the piscivores. *[2]*

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(d) Discuss how an understanding of biomagnification could help these human populations reduce their risk of mercury poisoning while maintaining their traditional diet. *[2]*

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G2. (a) Distinguish between biome and biosphere. *[1]*

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(b) Outline the characteristics of **three named** biomes including temperature, moisture and vegetation. An example has been provided. *[3]*

Biome	Temperature	Moisture	Vegetation
tropical rain forest	***hot, little fluctuation***	***wet***	***evergreen / stratified***

(This question continues on the following page)

(Question G2 continued)

(c) Outline the biogeographical features of nature reserves that promote the conservation of diversity. *[3]*

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G3. Discuss how international efforts can contribute to the conservation of fish stocks. *[6]*

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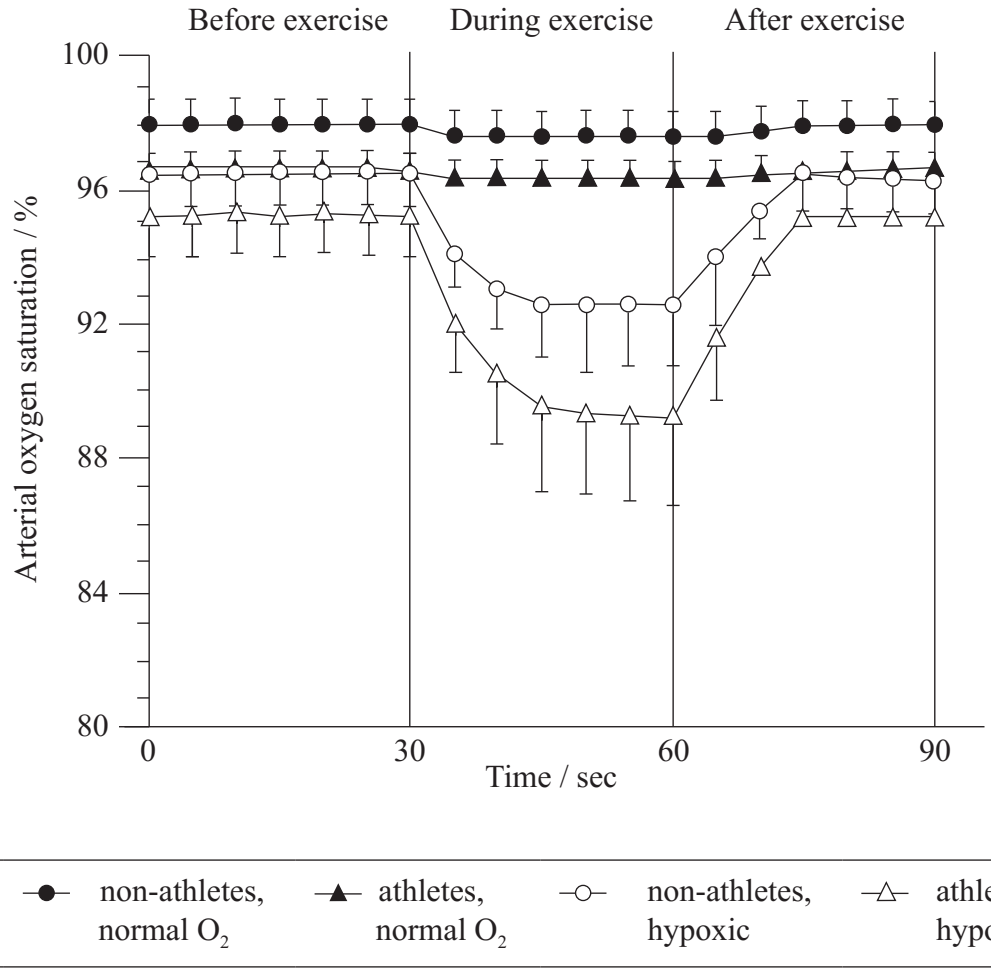
Option H — Further human physiology

H1. The effects of normal and hypoxic (lower than normal) oxygen concentrations on the oxygen levels in blood and muscles of athletes were investigated in a study. Healthy male non-athletes and athletes performed 30 seconds of intense maximal exertion exercise on a stationary bicycle. The data displayed below show the arterial oxygen saturation levels before, during and after the exercise.



[Source: K. Oguri et al. (2008), "Pronounced muscle deoxygenation during supramaximal exercise under simulated hypoxia in sprint athletes", *Journal of Sports Science and Medicine*, 7 (4), 512–519: Figure 3. Reprinted with permission from the *Journal of Sports Science and Medicine*.]

(a) Estimate the change in the arterial oxygen saturation between 30 and 60 seconds in non-athletes under hypoxic conditions. *[1]*

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(This question continues on the following page)

(Question H1 continued)

(b) (i) Compare the effect of hypoxic concentrations on athletes and non-athletes during exercise. *[2]*

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(ii) Suggest a reason for the differences. *[1]*

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(c) Explain how the body prevents oxygen saturation levels from falling by more than a small amount during maximal exertion exercise. *[2]*

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(d) Hypoxic concentrations also occur at high altitudes. Explain **one** effect of high altitude on oxygen transport by blood. *[1]*

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H2. (a) Distinguish between the mode of action of steroid and peptide hormones. *[2]*

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(b) Outline the control of gastric juice secretion. *[2]*

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(c) Explain the production and activation of pepsin. *[3]*

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H3. The liver is a complex organ with a wide range of functions. Outline the functions of the liver. *[6]*

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